

**Drainage Report**

**for**

**TENTATIVE PARCEL MAP NO. 20929  
ENVIRONMENTAL LOG: ER 05-02-011**

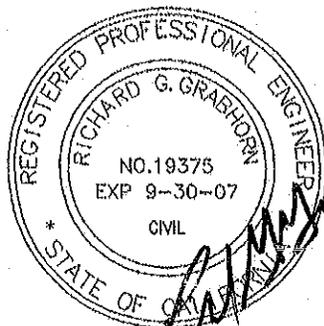
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## 1.0 Introduction

The purpose of this Drainage Study is to assess the quantity of storm runoff that will result from the improvements proposed by Tentative Parcel Map (TPM) No. 20929. This Drainage Study provides estimates of flood runoff from a 100-year frequency storm event for both existing and proposed site conditions using the methodology set forth in the San Diego County Hydrology Manual, June 2003 (the Manual). The requisite drainage facilities are shown on the Project Map included as Appendix 'A'.

## 1.1 Project Description

The Project is located on the east side of Cole Grade Road north of Miller Road and south of Cane Road in Valley Center, in the County of San Diego (See the location map on the next page). The project is approximately 460 feet north of Miller Road. This project will consist of grading and private road improvements for two residential lots at a density of 0.32 dwelling units per acre (du/ac). The project is 6.16 acres in size and proposes to disturb 2.91 acres of land including leach field construction. The project area is characterized by moderately sloping land and is currently utilized as an citrus grove. The project is surrounded on all sides by low density residential development. The majority of storm flows are conveyed away from the project by an existing 18" storm drain crossing under Cole Grade Road.

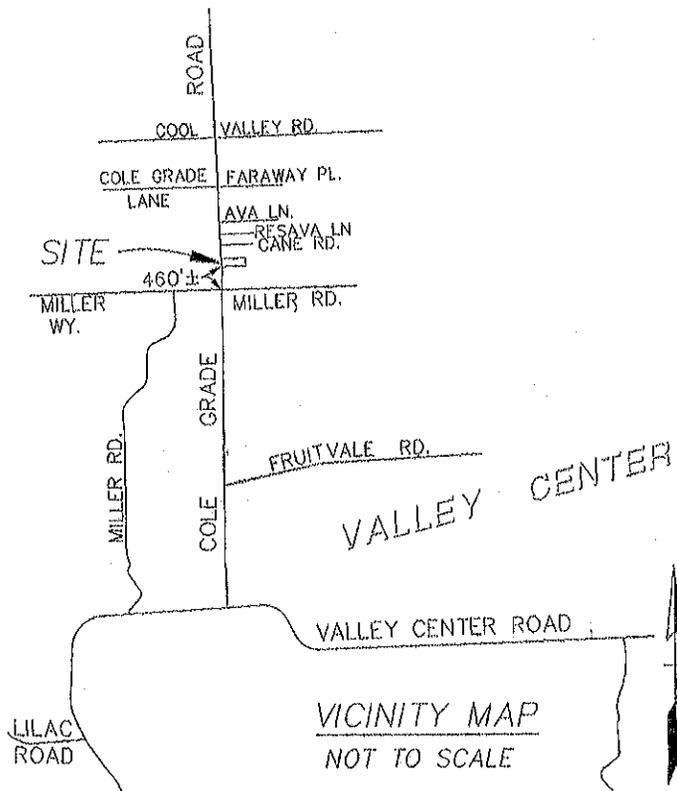
Although architectural plans have not yet been prepared, it is assumed that each lot will have an average building footprint of 2,350 sf not including private paved areas such as driveways and walkways.

## 1.2 Conclusion

In the existing condition, storm flows enter the site from the north, east and south sides and is primarily tributary to an existing 18" storm drain crossing under Cole Grade Road (Node 1). The storm flows are carried across the site by surface flow over moderately sloping terrain. In the developed condition, the storm flow patterns will be similar to the existing condition. A small part of the south east area of the project drains to the south (Node 2), not to the existing 18" storm drain crossing under Cole Grade Road. The project has been designed to keep this drainage pattern intact.

The drainage areas in the existing and developed condition are substantially the same. The runoff at the southeasterly project corner (Node 2) decreases from 3.19 cfs in the existing condition to 2.75 cfs in the developed condition. At the southwest corner (Node 1), in the existing condition the 100 year storm flow from the project site and offsite tributary areas is 29.23 cfs. In the proposed condition, the 100 year storm flow from the project site and tributary areas is 27.97 cfs. The minor reductions in storm runoff are primarily due to the longer time of concentration that results from the introduction of flat pad areas. The capacity of the existing 18" storm drain under Cole Grade Road is 23.3 cfs. In the developed 100 year condition, approximately 4.67 cfs will flow across the surface of Cole Grade Road, compared with the approximately 5.93 cfs of sheet flow that would be experienced under existing conditions. This is based on graphic interpretation of Road Survey 680 which indicates that approximately 7.6' of head at the inlet is available without flooding the center traveled lanes of Cole Grade Road.

# LOCATION MAP



## 2.0 Technical Report

### 2.1 Basis of Evaluation

The following technical report provides estimates of 100-year frequency flows under both existing and proposed conditions. The County of San Diego Hydrology Manual, June 2003, was used as the basis of these calculations.

Various charts and formulas set forth in the Standards are provided for the reader's convenience. In general, the formulas were used in lieu of graphic interpretation of design aid charts.

The various formulas used in this study are as follows:

#### Urban Overland Flow Time of Concentration

$$T_c = \frac{1.8 (1.1 - C) D^{1/2}}{S^{1/3}}$$

Where  $T_c$  = Time of concentration in minutes  
 $C$  = Coefficient of runoff  
 $D$  = Distance of flow route in feet  
 $S$  = Slope of the tributary area along the flow route in percent

#### Volume of Flow

$$Q = CIA$$

Where  $Q$  = Volume in cubic feet per second (CFS)  
 $I$  = Rainfall intensity  
 $A$  = Tributary area in acres

#### Time of concentration for natural watersheds

$$T_c = 60 \left( \frac{11.9L^3}{H} \right)^{.385}$$

Where  $T_c$  = Time of concentration in minutes.  
 $L$  = Length along flow route in miles  
 $H$  = Effective height of tributary basin in feet

#### Rainfall

$$\text{Intensity } I = 7.44 P_6 D^{.645}$$

Where  $I$  = Rainfall intensity in inches  
 $P_6$  = 6-hour precipitation in minutes (i.e.: 3.7)  
 $D$  = Duration in minutes (i.e.: time of concentration)

## 2.2 Runoff Coefficient

Soil Groups C & D affect this small hydrologic basin of approximately 21 acres. The runoff coefficients for various conditions used in this report are as follows:

SOILS GROUP	NATURAL	LDR-1
C	0.30	0.35
D	0.36	0.41

For the existing condition analysis, the C-Values for natural conditions were used for the subject property. Low density residential, one du/ac (LDR-1) runoff coefficients were used for the entire project area to evaluate proposed conditions. For all off-site tributary areas, LDR-1 runoff coefficients were used for both existing and proposed conditions.

Where different soil groups exist within a sub-basin, an area weighted C-Value was calculated for the total sub-basin. Area weighted runoff coefficients are shown in Appendix B, Existing Conditions Hydrology Map and Appendix C, Developed Conditions Hydrology Map.

**2.3 Runoff Calculations**  
**TPM 20929**  
**EXISTING CONDITIONS**

**BASE INFORMATION**

P-6      3.7

DENSITY: 0 DU/AC

NATURAL TERRAIN

LONGITUDE      117° 01' 17"

LATITUDE        33° 15' 28"

RUNOFF COEFF (C) - SEE APPENDIX 'B', HYDROLOGY MAP, EXISTING CONDITION

EXISTING CONDITIONS

NODE AREA  
NUMBER NUMBER  
1 1

INITIAL TIME, POINT 1 TO 2  
EFF.

TI (MIN)	Lm (FT)	HIGH PT	LOW PT	SLOPE (%)	C
9.947	100	1666.5	1664	2.500	0.35

$$T_c = \frac{1.8(1.1-C)D^{1/2}}{S^{1/3}}$$

TIME OF CONCENTRATION, POINT 2 TO NODE 1

Tt (MIN)	LENGTH (FT)	HIGH PT EFF.	LOW PT	SLOPE (%)	C
6.966	1525	1664	1587	5.049	

$$T_c = 60 \left( \frac{11.9 L^3}{H} \right)^{.386}$$

TIME	=	TI	+	Tt
16.913		9.947		6.966

I (IN/HR)	P-6 (IN)	DURATION (MIN)
4.442	3.7	16.913

$$I = 7.44 P_0^{.645} D$$

LOCAL BASIN "Q"

Local Q adj(cfs)	C	I (IN/HR)	A (ACRES)
23.373	0.336	4.442	15.66

$$Q = CIA$$

EXISTING CONDITIONS

NODE AREA  
NUMBER NUMBER  
1 2

INITIAL TIME, POINT 3 TO 4

TI (MIN)	Lm (FT)	EFF. HIGH PT	LOW PT	SLOPE (%)	C
7.349	100	1642.0	1635.8	6.200	0.35

$$T_c = \frac{1.8(1.1-C)D^{1/2}}{S^{1/3}}$$

TIME OF CONCENTRATION, POINT 4 TO NODE 1

Tt (MIN)	LENGTH (FT)	EFF. HIGH PT	LOW PT	SLOPE (%)	C
3.350	695	1635.8	1587.0	7.022	

$$T_c = 60 \left( \frac{11.9 L^3}{H} \right)^{.385}$$

TIME = TI + Tt  
10.699 = 7.349 + 3.350

I (IN/HR)	P-6 (IN)	DURATION (MIN)
5.968	3.7	10.699

$$I = 7.44 P_6 D^{-.645}$$

LOCAL BASIN "Q"

Local Q (CFS)	C	I (IN/HR)	A (ACRES)
7.861	0.373	5.968	3.54

$$Q = CIA$$

EXISTING CONDITIONS

NODE AREA  
NUMBER NUMBER  
2 3

INITIAL TIME, POINT 1 TO 5  
EFF.

Tl (MIN)	Lm- (FT)	HIGH PT EFF.	LOW PT	SLOPE (%)	C
7.429	100	1666.5	1660.5	6.000	0.35

$$T_c = \frac{1.8(1.1-C)D^{1/2}}{S^{1/3}}$$

TIME OF CONCENTRATION, POINT 5 TO NODE 2

Tt (MIN)	LENGTH (FT)	HIGH PT EFF.	LOW PT	SLOPE (%)	C
1.899	375	1660.5	1627	8.933	

$$T_c = 60 \left( \frac{11.9 L^3}{H} \right)^{.386}$$

TIME = Tl + Tt  
9.328 = 7.429 + 1.899

I (IN/HR)	P-6 (IN)	DURATION (MIN)
6.520	3.7	9.328

$$I = 7.44 P_6 D^{.645}$$

LOCAL BASIN "Q"

Local Q adj(cfs)	C	I (IN/HR)	A (ACRES)
3.19	0.331	6.520	1.48

$$Q = CIA$$

**TPM 20929  
DEVELOPED CONDITIONS**

**BASE INFORMATION**

P-6      3.7

PROPOSED DENSITY: 0.3 DU/AC

LOW DENSITY RESIDENTIAL (LDR-1)

LONGITUDE      117° 01' 17"

LATITUDE      33° 15' 28"

**RUNOFF COEFF (C) - APPENDIX 'C', HYDROLOGY MAP-PROPOSED CONDITIONS**

DEVELOPED CONDITIONS

NODE AREA  
NUMBER NUMBER  
1 1

INITIAL TIME EFF.  
TI Lm HIGH PT LOW PT SLOPE  
(MIN) (FT) (%)

**TI=11.6 (Manual Table 3-2)**

C

$$T_c = \frac{1.8(1.1-C)D^{1/2}}{S^{1/3}}$$

TIME OF CONCENTRATION

Tt<sub>1</sub> LENGTH HIGH PT LOW PT SLOPE  
(MIN) (FT) EFF. (%)  
1.470 90 1629.3 1628.4 1.000

C

$$T_c = 60 \left( \frac{11.9 L^3}{H} \right)^{.388}$$

Tt<sub>2</sub> LENGTH HIGH PT LOW PT SLOPE  
(MIN) (FT) EFF. (%)  
6.289 1135 1628.4 1587 3.648

C

$$T_c = 60 \left( \frac{11.9 L^3}{H} \right)^{.6}$$

TIME = TI + Tt<sub>1</sub> + Tt<sub>2</sub>  
19.259 = 11.500 + 1.470 + 6.289

I P-6 DURATION  
(IN/HR) (IN) (MIN)  
4.085 3.7 19.259

$$I = 7.44 P_6 D^{-.645}$$

LOCAL BASIN "Q"

Local Q C I A  
(CFS) (IN/HR) (ACRES)  
22.581 0.353 4.085 15.66

$$Q = CIA$$

NODE AREA  
NUMBER NUMBER  
1 2

SAME AS EXISTING CONDITIONS

Q<sub>100</sub>=7.88, T=10.698, & I=5.969

DEVELOPED CONDITIONS

NODE	AREA
NUMBER	NUMBER
2	3

INITIAL TIME		EFF.		
T <sub>i</sub>	L <sub>m</sub>	HIGH PT	LOW PT	SLOPE
(MIN)	(FT)			(%)

**T<sub>i</sub>=11.5 (Manual Table 3-2)**

C

$$T_c = \frac{1.8(1.1-C)D^{1/2}}{S^{1/3}}$$

TIME OF CONCENTRATION				
T <sub>t</sub>	LENGTH	HIGH PT	LOW PT	SLOPE
(MIN)	(FT)	EFF.		(%)
1.36	115	1629.3	1627	2.000

C

$$T_c = 60 \left( \frac{11.9 L^3}{H} \right)^{.985}$$

TIME		T <sub>i</sub>		T <sub>t</sub>
12.860	=	11.5	+	1.36

I	P-6	DURATION
(IN/HR)	(IN)	(MIN)
5.300	3.7	12.860

$$I = 7.44 P_0 D^{-.648}$$

LOCAL BASIN "Q"			
Local Q	C	I	A
(CFS)		(IN/HR)	(ACRES)
2.746	0.35	5.300	1.48

$$Q = CIA$$

DEVELOPED CONDITIONS

NODE AREA  
 NUMBER NUMBER  
 3 4

FROM ANALYSIS OF NODE 1 / AREA 1, TC @ POINT 3 =12.97 MIN.

TIME OF CONCENTRATION, POINT 3 TO NODE 3

Tt (MIN)	LENGTH (FT)	HIGH PT EFF.	LOW PT	SLOPE (%)
5.079	920	1628.4	1590	4.174

C

$$T_c = 60 \left( \frac{11.9 L^3}{H} \right)^{.385}$$

TIME	=	Tl	+	Tt
18.05		12.97		5.079

I (IN/HR)	P-6 (IN)	DURATION (MIN)
4.260	3.7	18.05

$$I = 7.44 P_6 D^{-.645}$$

LOCAL BASIN "Q"

Local Q (CFS)	C	I (IN/HR)	A (ACRES)
16.64	0.35	4.260	11.16

$$Q = CIA$$

**AREA SUMMARY**

**EXISTING CONDITIONS**

NODE	AREA I.D.	AREA (AC)	C	Tc (MIN)	I	Q-100 (CFS)
1	1	15.66	0.336	16.91	4.44	23.36
1	2	3.54	0.373	10.70	5.97	7.88
2	3	1.48	0.331	9.33	6.52	3.19
		<u>20.68</u>				

**DEVELOPED CONDITIONS**

NODE	AREA I.D.	AREA (AC)	C	Tc (MIN)	I	Q-100 (CFS)
1	1	15.66	0.353	19.26	4.085	22.58
1	2	3.54	0.373	10.70	5.97	7.88
2	3	1.48	0.350	12.86	5.30	2.75
		<u>20.68</u>				

**CONFLUENCE CALCULATION - EXISTING CONDITIONS: NODE 1**

$$Q = 23.36 + 7.88(4.44/5.97)$$

$$Q = 29.22$$

**CONFLUENCE CALCULATION - DEVELOPED CONDITIONS: NODE 1**

$$Q = 22.58 + 7.88(4.085/5.97)$$

$$Q = 27.97$$

**COMPARISON OF EXISTING TO DEVELOPED HYDROLOGY**

	NODE 1			NODE 2		
	Q	I	Tc	Q	I	Tc
EXISTING CONDITIONS	29.22	4.44	16.91	3.19	6.52	9.33
DEVELOPED CONDITIONS	27.97	4.085	19.26	2.75	5.30	12.86

PIPE CULVERT ANALYSIS  
COMPUTATION OF CULVERT PERFORMANCE CURVE

January 17, 2006

PROPOSED TWIN 18" RCP CULVERT UNDER PRIVATE ROAD AT NODE 3  
Q<sub>TOTAL</sub> = 16.64 cfs, Q/2=8.32

DESCRIPTION	PROGRAM INPUT DATA	VALUE
Culvert Diameter (ft).....		1.5
FHWA Chart Number.....		1
FHWA scale Number (Type of Culvert Entrance).....		1
Manning's Roughness Coefficient (n-value).....		0.013
Entrance Loss Coefficient of Culvert Opening.....		0.5
Culvert Length (ft).....		47.0
Invert Elevation at Downstream end of Culvert (ft).....		1,589.53
Invert Elevation at Upstream end of Culvert (ft).....		1,590.0
Culvert slope (ft/ft).....		0.01
Starting Flow Rate (cfs).....		8.32
Incremental Flow Rate (cfs).....		0.0
Ending Flow Rate (cfs).....		8.32
Starting Tailwater Depth (ft).....		0.0
Incremental Tailwater Depth (ft).....		0.0
Ending Tailwater Depth (ft).....		0.0

COMPUTATION RESULTS							
Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at outlet (ft)	Outlet Velocity (fps)
8.32	0.0	1.91	0.0	1.01	1.12	1.01	6.59

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COMPUTATION OF CULVERT PERFORMANCE CURVE

January 17, 2006

EXISTING 18" CMP UNDER COLE GRADE ROAD

PROGRAM INPUT DATA	
HEAD AVAILABLE @ INLET ≈ 7.6 [R.S. 680]	
DESCRIPTION	VALUE
Culvert Diameter (ft).....	1.5
FHWA Chart Number.....	2
FHWA Scale Number (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.024
Entrance Loss Coefficient of Culvert Opening.....	0.5
Culvert Length (ft).....	85.0
Invert Elevation at Downstream end of Culvert (ft).....	1,581.4
Invert Elevation at Upstream end of Culvert (ft).....	1,584.86
Culvert slope (ft/ft).....	0.0407
Starting Flow Rate (cfs).....	22.0
Incremental Flow Rate (cfs).....	0.1
Ending Flow Rate (cfs).....	24.0
Starting Tailwater Depth (ft).....	0.0
Incremental Tailwater Depth (ft).....	1.0
Ending Tailwater Depth (ft).....	20.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater Inlet Control (ft)	Headwater Outlet Control (ft)	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
22.0	0.0	6.88	11.95	1.5	1.48	1.48	12.49
22.1	1.0	6.93	12.07	1.5	1.48	1.48	12.54
22.2	2.0	6.99	15.16	1.5	1.48	1.5	12.56
22.3	3.0	7.04	16.31	1.5	1.48	1.5	12.62
22.4	4.0	7.09	17.46	1.5	1.48	1.5	12.68
22.5	5.0	7.15	18.61	1.5	1.48	1.5	12.73
22.6	6.0	7.2	19.76	1.5	1.48	1.5	12.79
22.7	7.0	7.26	20.92	1.5	1.48	1.5	12.85
22.8	8.0	7.31	22.07	1.5	1.48	1.5	12.9
22.9	9.0	7.37	23.22	1.5	1.48	1.5	12.96
23.0	10.0	7.42	24.38	1.5	1.48	1.5	13.02
23.1	11.0	7.48	25.53	1.5	1.48	1.5	13.07
23.2	12.0	7.54	26.69	1.5	1.48	1.5	13.13
23.3	13.0	7.59	27.85	1.5	1.48	1.5	13.19
23.4	14.0	7.65	29.01	1.5	1.48	1.5	13.24
23.5	15.0	7.71	30.16	1.5	1.48	1.5	13.3
23.6	16.0	7.76	31.32	1.5	1.48	1.5	13.35
23.7	17.0	7.82	32.48	1.5	1.48	1.5	13.41
23.8	18.0	7.88	33.64	1.5	1.48	1.5	13.47
23.9	19.0	7.94	34.8	1.5	1.48	1.5	13.52
24.0	20.0	8.0	35.96	1.5	1.48	1.5	13.58

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# ATTACHMENTS

San Diego County Hydrology Manual  
Date: June 2003

Table 3-1  
RUNOFF COEFFICIENTS FOR URBAN AREAS

NRCES Elements	County Elements	Runoff Coefficient "C"			
		% IMPER.	A	B	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84
Commercial/Industrial (Limited I)	Limited Industrial	90	0.83	0.84	0.84
Commercial/Industrial (General I)	General Industrial	95	0.87	0.87	0.87

\*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).

DU/A = dwelling units per acre

NRCES = National Resources Conservation Service

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

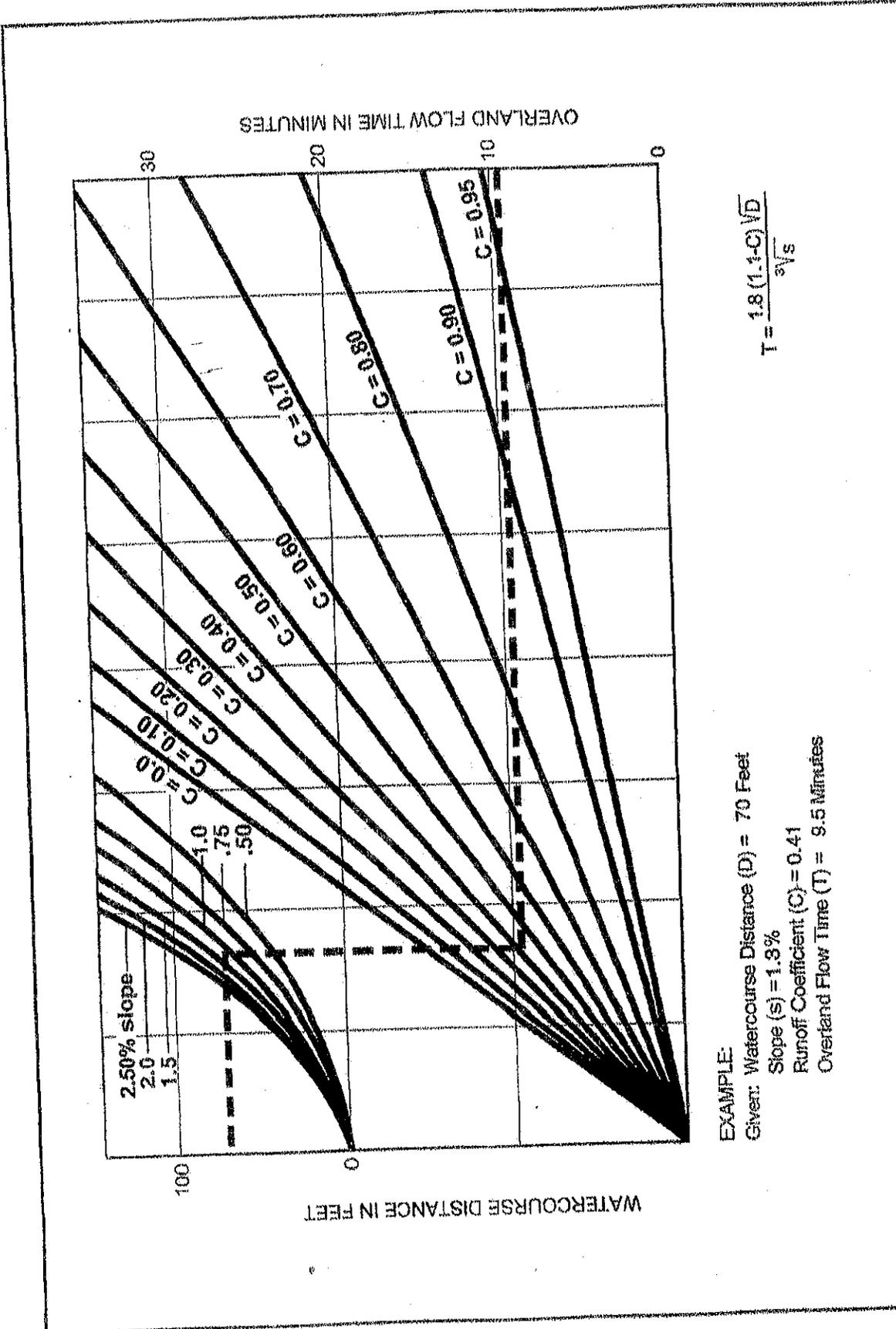
Table 3-2 provides limits of the length (Maximum Length ( $L_M$ )) of sheet flow to be used in hydrology studies. Initial  $T_i$  values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

**MAXIMUM OVERLAND FLOW LENGTH ( $L_M$ )  
 & INITIAL TIME OF CONCENTRATION ( $T_i$ )**

Element*	DU/ Acre	.5%		1%		2%		3%		5%		10%	
		$L_M$	$T_i$										
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

\*See Table 3-1 for more detailed description



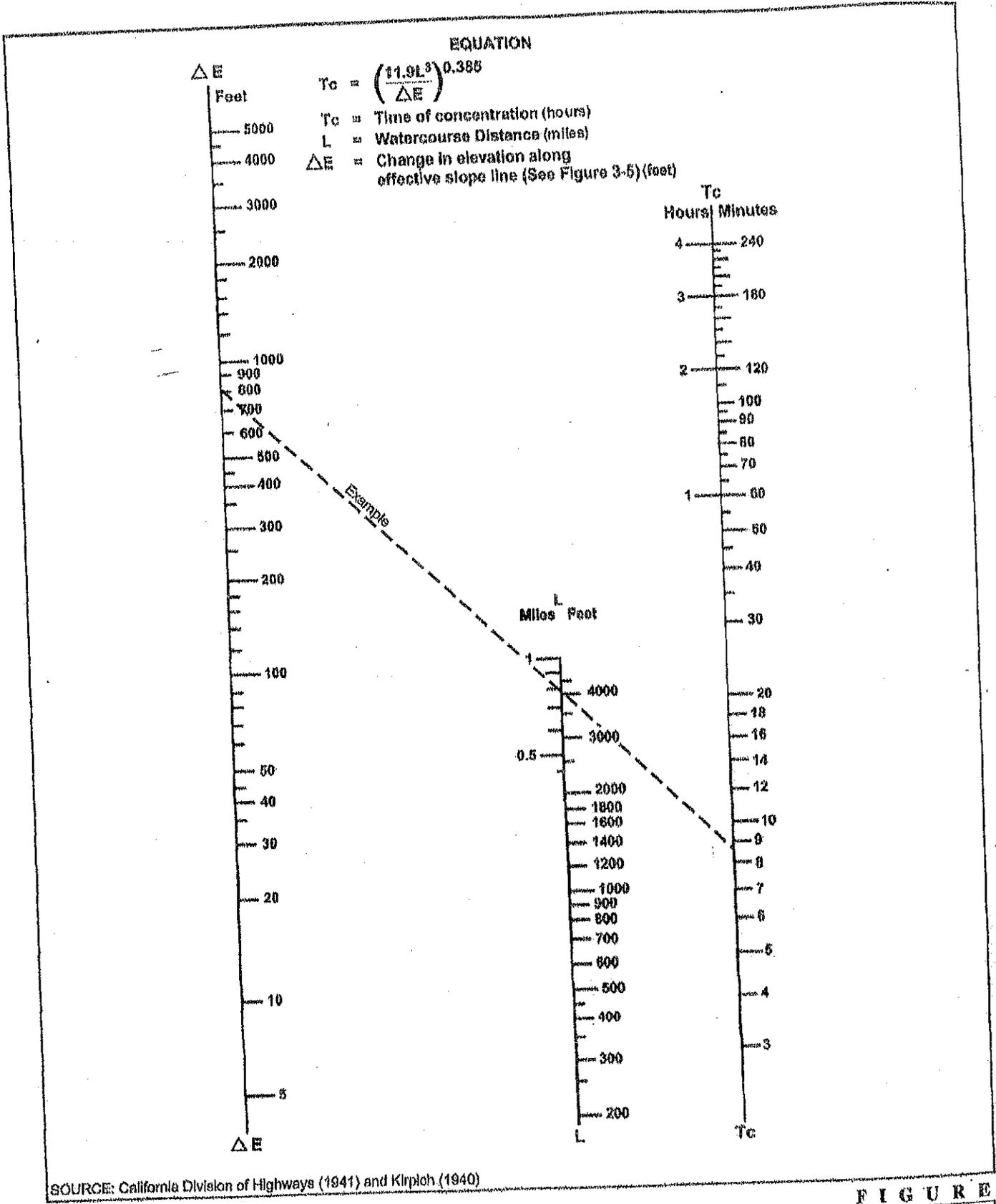
$$T = \frac{1.8(1.1-C)\sqrt{D}}{s\sqrt{s}}$$

FIGURE

3-3

Rational Formula - Overland Time of Flow Nomograph

SOURCE: Airport Drainage, Federal Aviation Administration, 1965



SOURCE: California Division of Highways (1941) and Kirpich (1940)

Nomograph for Determination of  
Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ ) for Natural Watersheds

**FIGURE**  
**3-4**



# Rainfall Isopleths

100 Year Rainfall Event - 6 Hours

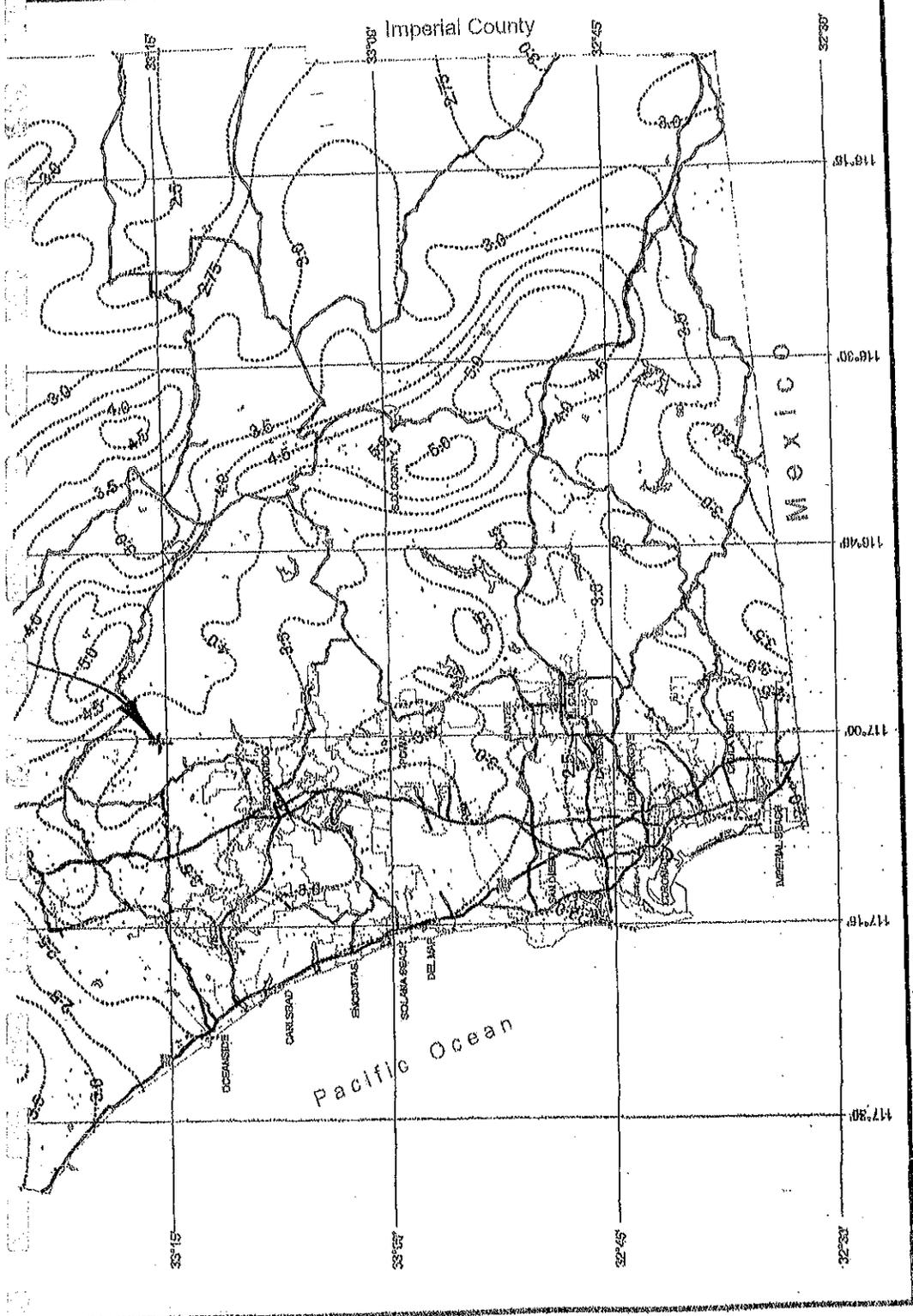


$$I = 3.7 \text{ IN/HR}$$

GIS



3 0 3 Miles

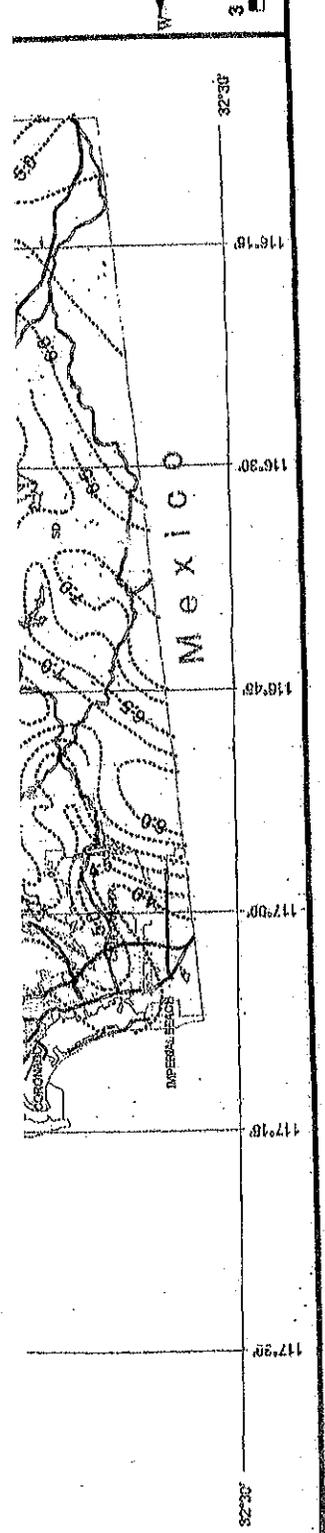


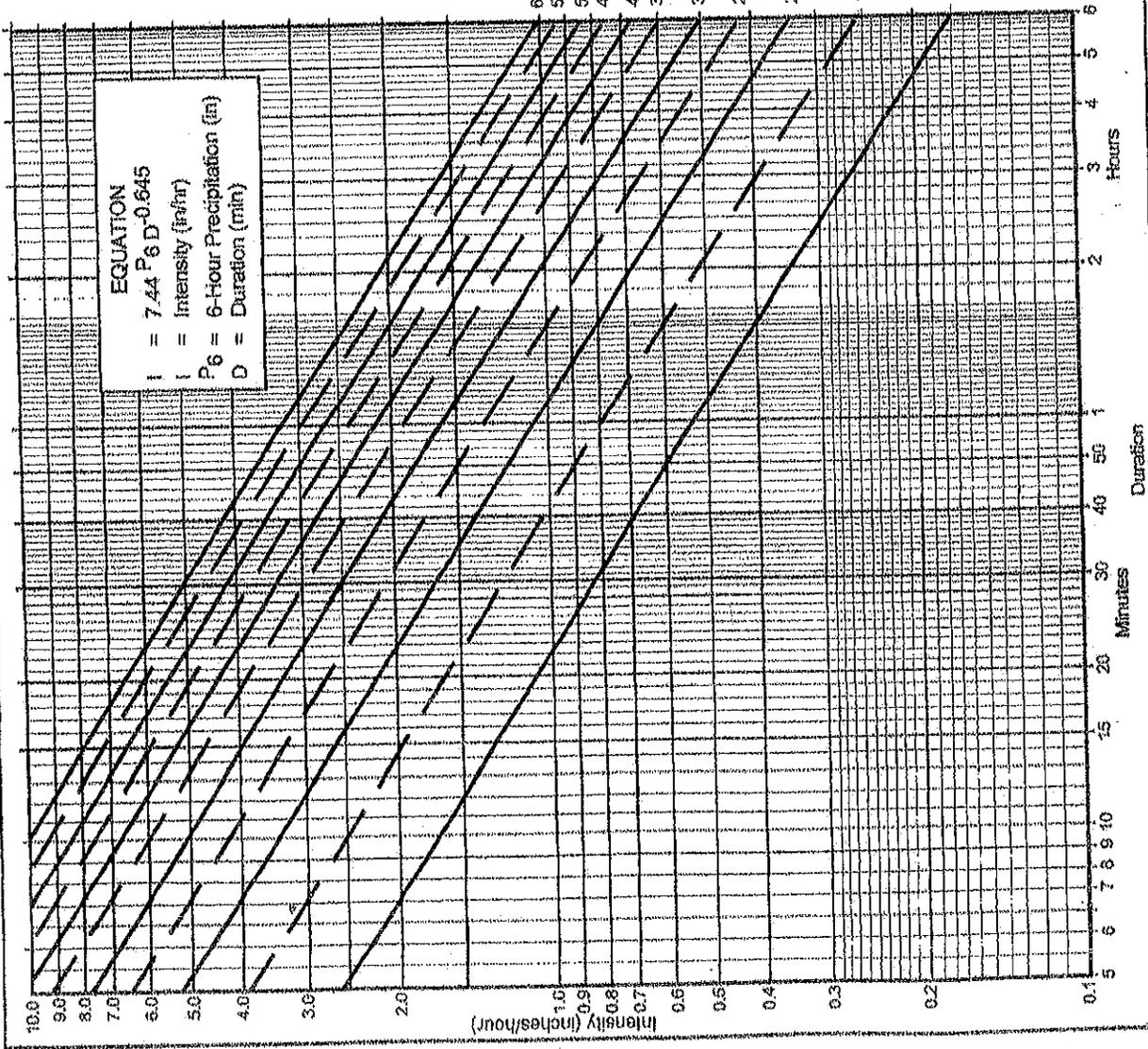
GIS

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 COUNTY OF IMPERIAL  
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3 0 3 Miles





**Directions for Application:**

- (1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).
- (2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicable to Desert).
- (3) Plot 6 hr precipitation on the right side of the chart.
- (4) Draw a line through the point parallel to the plotted lines.
- (5) This line is the intensity-duration curve for the location being analyzed.

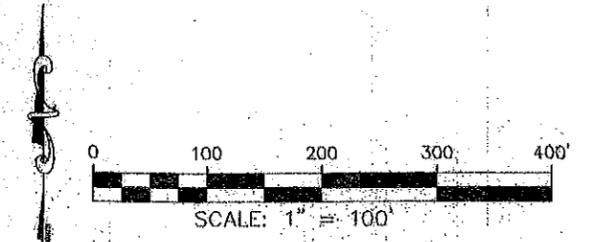
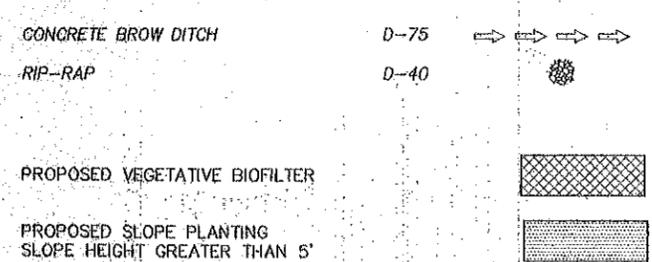
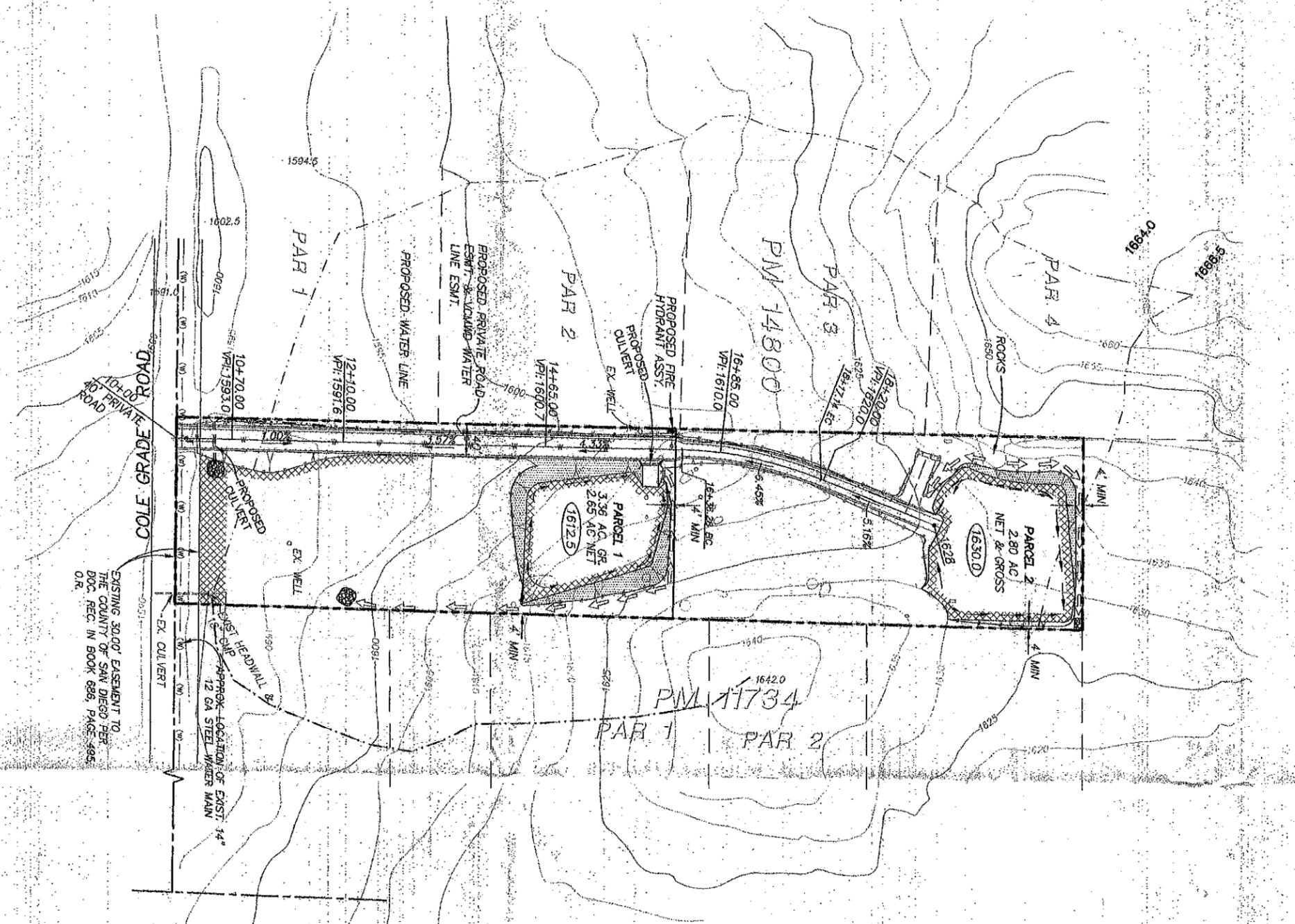
**Application Form:**

- (a) Selected frequency 100 year  
 (b)  $P_6 = 3.7$  in.,  $P_{24} = 8.0$ ,  $\frac{P_6}{P_{24}} = \frac{46}{100} \% P_2$   
 (c) Adjusted  $P_6^{(2)} = 3.7$  in.  
 (d)  $t_x =$  \_\_\_\_\_ min.  
 (e)  $i =$  \_\_\_\_\_ in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

$P_6$	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Duration	5	7	10	15	20	30	40	60	90	120	180
2.53	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81	17.13
2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72	13.78
1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11	10.95
1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78	8.43
2.0	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.53	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.65	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.06	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.96	1.19	1.46	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.05	1.33	1.59	1.86	2.12	2.39	2.66	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.52	1.67	1.82	1.97
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.36	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template



ENGINEER:  
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*Richard G. Grabhorn*  
 RICHARD G. GRABHORN  
 RCE 19375



### PROJECT MAP

**goc** GRABHORN ENGINEERING CORP  
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 San Diego, CA 92123  
 (858) 576-6343 Tel  
 (858) 576-6334 Fax

# HYDROLOGY MAP - DEVELOPED CONDITIONS

SOIL GROUP	NAT	LDR-1
C	0.30	0.35
D	0.36	0.41

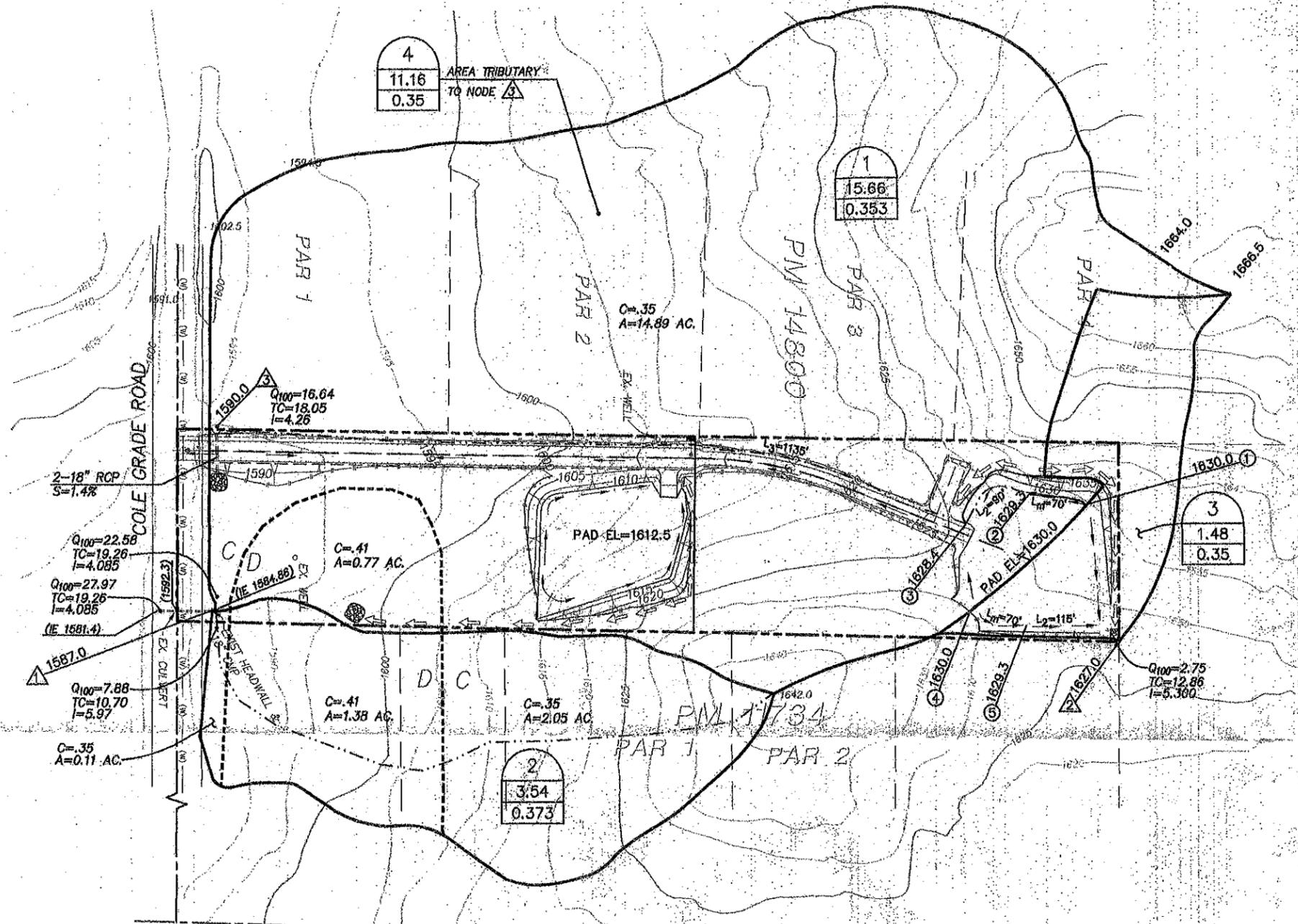
PER MANUAL TABLE 3-1

### WEIGHTED C VALUES

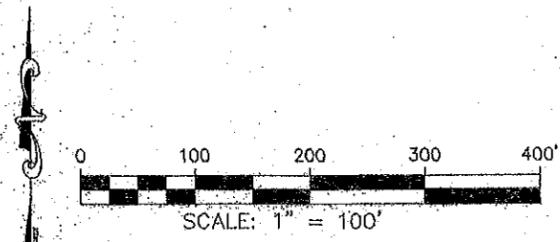
AREA 1 (AC)		
C	X AREA	=
.35	X 14.89	= 5.2115
.41	X 0.77	= 0.3157
(.353)	15.66	5.5272

AREA 2 (AC)		
C	X AREA	=
.35	X 0.11	= 0.0385
.41	X 1.38	= 0.5658
.35	X 2.05	= 0.7175
(.373)	3.54	1.3210

AREA 3 (AC)		
C	X AREA	=
.35	X 1.48	= 0.5180
(.350)	1.48	0.5180



- LEGEND:**
- PROJECT BOUNDARY
  - AREA ID
  - AREA (IN ACRES)
  - C VALUE
  - NODE ID
  - POINT ID
  - FLOWLINE



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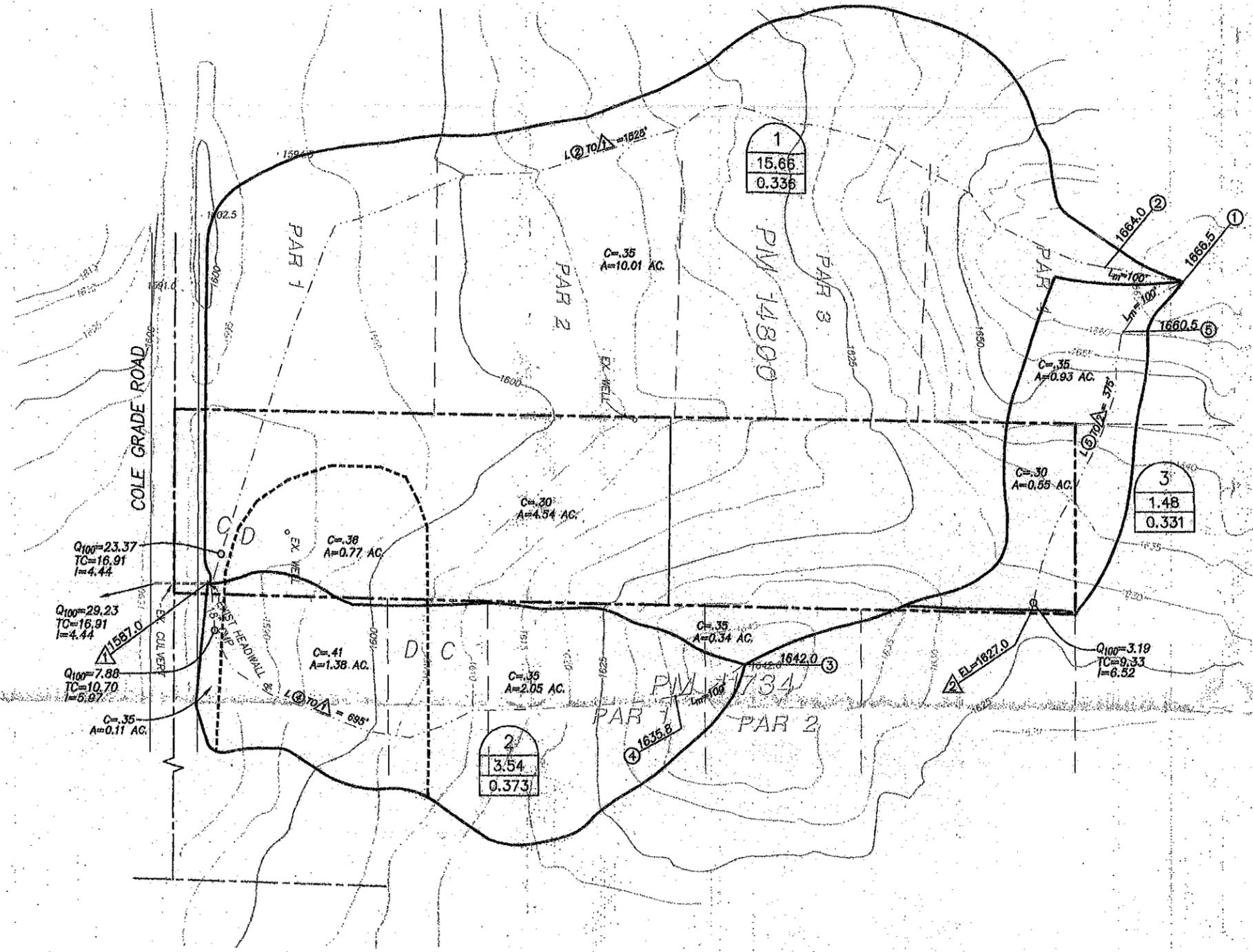
DEVELOPED CONDITIONS - Q<sub>100</sub>

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 San Diego, CA 92123  
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# HYDROLOGY MAP - EXISTING CONDITIONS

SOIL GROUP	NAT	LDR-1
C	0.30	0.35
D	0.36	0.41

PER MANUAL TABLE 3-1



### WEIGHTED C VALUES

**AREA 1 (AC)**

C	X AREA	=
.36	X 10.01	= 3.5036
.30	X 4.54	= 1.3620
.36	X 0.77	= 0.2772
.35	X 0.34	= 0.1190
(.336)	15.66	5.2617

**AREA 2 (AC)**

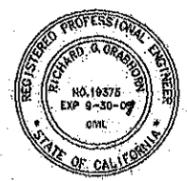
C	X AREA	=
.35	X 0.11	= 0.0385
.41	X 1.38	= 0.5658
.35	X 2.05	= 0.7175
(.373)	3.54	1.3218

**AREA 3 (AC)**

C	X AREA	=
.35	X 0.93	= 0.3255
.30	X 0.55	= 0.1650
(.331)	1.48	0.4905

### LEGEND:

- PROJECT BOUNDARY
- AREA ID
- AREA (IN ACRES)
- C VALUE
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 RICHARD G. GRABHORN  
 RCE 19375

EXISTING CONDITIONS - Q<sub>100</sub>

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